Energy & Enzymes

Part A: Enzymes In general, enzymes are protein molecules which must be folded in a specific three-dimensional shape in order to function properly. Certain environmental parameters can affect enzyme activity, including pH and temperature. If an enzyme's shape changes significantly and it can no longer function, the enzyme is said to have become denatured.

The enzyme pancreatic amylase is manufactured and secreted by the pancreas into the duodenum (the large, beginning portion of the small intestine). Pancreatic amylase breaks down starch into maltose, a disaccharide. Pepsin is an enzyme that is released by the epithelium of the stomach, and functions in the stomach to break down proteins into smaller polypeptide units. The following graphs show the activities of various enzymes under various environmental conditions.

Figure 1

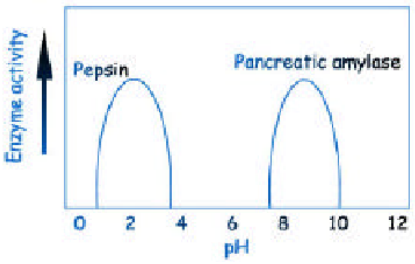
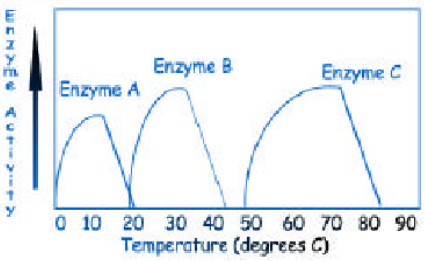


Figure 2



1) Which of the following statements is true with respect to Figure 1?
   a) Pepsin and pancreatic amylase could never function together in the same part of the body at the same time.
   b) Pancreatic amylase could function in the stomach, but its activity would be low.
   c) The optimal pH for the functioning of pepsin is approximately 8.5.
   d) Normally, the small intestine must be slightly acidic.
2) Trypsin is a protein digesting enzyme that functions in the small intestine. Which of the following statements should be true about trypsin?
   a) The optimum pH for the functioning of trypsin is approximately 2.
   b) Both trypsin and pepsin would be expected to be found working together in the same part of the body.
   c) The optimum pH for the functioning of trypsin is approximately 8.5.
   d) Trypsin could function well in a solution containing 1 molar hydrochloric acid.
3) Figure 2 depicts the activities of three enzymes. Which curve illustrates the functioning of human DNA polymerase, which functions in the nucleus of cells?
   a) Enzyme A
   b) Enzyme B
   c) Enzyme C
   d) None of the above could represent the activity of human DNA polymerase.
4) Which curve illustrates the functioning of DNA polymerase from a shark?
   a) Enzyme A
   b) Enzyme B
   c) Enzyme C
   d) None of the above, since sharks, like all fish, do not contain DNA polymerase.
5) At what temperature would enzyme B be completely denatured?
   a) 37°C
   b) 15°C
   c) 5°C
   d) 50°C

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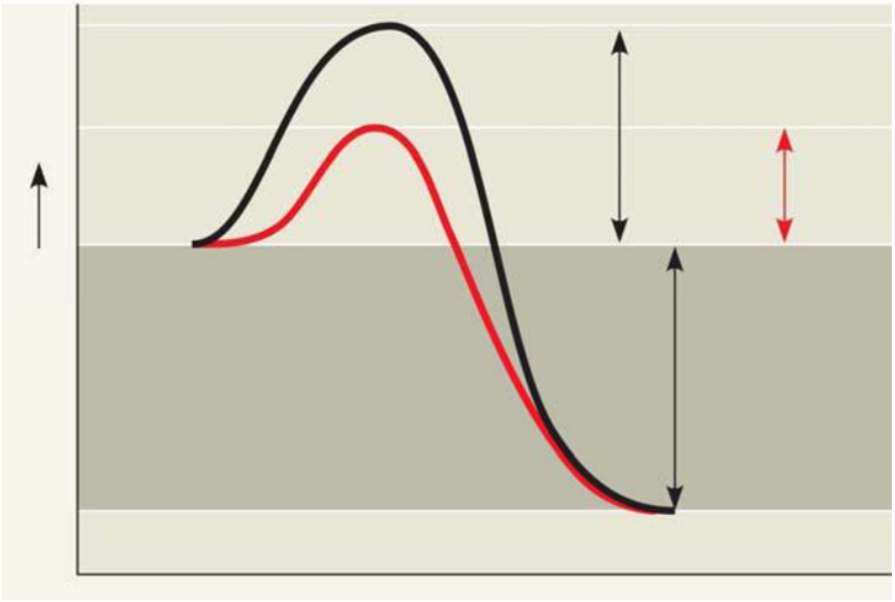
1. What is a *catalyst*?

2. What is activation energy (EA)?

3. On the graph below, label the x-axis "Progress of the reaction" and the y-axis "Free Energy." Label EA on this sketch, both with and without enzyme.

a. What effect does an enzyme have on EA?



4. For #3 above, explain how you know which lines represent with enzyme and without enzyme.

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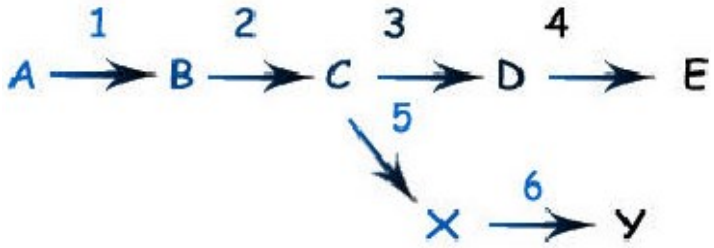
1) Consider a biochemical reaction A $\rightarrow$ B, which is catalyzed by the enzyme A-B dehydrogenase. Which of the following statements is true?
   a) The reaction will proceed until the enzyme concentration decreases.
   b) The reaction will be more favorable at body temperature.
   c) A component of the enzyme is transferred from A to B
   d) The free energy change, ΔG of the catalyzed reaction is the same as the free energy of the uncatalyzed reaction.

2) Consider the following enzyme pathway depicted below, an increase in [E] leads to the inhibition of enzyme 3. Which of the following will be affected by this process?



a) [A]
b) [B]
c) [C]
d) [D]
e) [X]
f) [Y]
g) all of the above
h) none of the above

3) Some enzymes require the presence of an organic non-protein molecule in order to behave catalytically. This organic non-protein molecule is called a(n):
   a) holoenzyme.
   b) apoenzyme.
   c) coenzyme.
   d) ymoenzyme.
   e) cofactor.
4) Some enzymes require the presence of an inorganic atom or molecule in order to behave catalytically. This inorganic atom or molecule is called a(n):
   a) holoenzyme.
   b) apoenzyme.
   c) coenzyme.
   d) ymoenzyme.
   e) cofactor.
5) Enzymes increase the rate of a reaction by
   a) decreasing the activation energy.
   b) aligning the reactants in the transition state.
   c) Both A and B
   d) None of the above
6) A young child is rushed to the emergency room after ingesting ethylene glycol. Although it is not itself harmful, ethylene glycol is quickly oxidized by alcohol dehydrogenase and then undergoes further oxidation reactions to form a lethally toxic compound. Doctors respond by administering high doses of ethanol, which inhibits the oxidation of ethylene glycol. Which of the following mechanisms best explains ethanol's role in the treatment?
   a) Ethanol competes with ethylene glycol for the active site of the enzyme.
   b) Ethanol competes with alcohol dehydrogenase for the enzyme.
   c) Ethanol detoxifies the lethal compound.
   d) Ethanol oxidizes the lethally toxic compound back into ethylene glycol.